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BRUCELLOSIS IN FACT AND FICTION: THE STORY OF A ZOONOSIS

Karen Sayer

'The careful study of this disease appeals to us not only as medical men but as members of a great empire.' (J.W.H. Eyre, Milroy Lecture 'Melitensis Septicemia Malta or Mediterranean Fever') *The Lancet* 13th June 1908

INTRODUCTION

The disease 'Brucellosis,' which was named ultimately after bacteriologist and pathologist Captain David Bruce (1855-1931), has many common, and often obsolete, names. Among the most frequently occurring we find: 'Crimean fever', 'Mediterranean fever' and 'Malta fever' after the locations in which it was initially observed; 'remittent fever' and 'undulant fever' after its presentation (coined in 1897 by M.L. Hughes); 'Bang's disease' after veterinarian Bernhard Bang who isolated *Brucella abortus* (1897); and 'goat fever' because unpasteurized goats' milk was found at the end of the nineteenth and early twentieth century to be one of the leading causes of infection (Fig. 2). Before it officially became Brucellosis, following the findings of the Mediterranean Fever Commission (which reported in 1905), it was called Melitensis Septicemia, and in 1893 Bruce himself had called it *Micrococcus melitensis*, both derived from the Classical name for Malta (in Latin, *Melite*, Greek, *Μελίτη*,¹ for the honey produced there) where the Commission undertook its research. The common names, the early scientific names and later the taxonomy of the genus *Brucella*, in the family Brucellaceae (family III), which itself is still a cause for debate,² all testify to the incredibly complex history of the human encounter with the various strains of *Brucella* bacteria, to its scientific identification as a cause of disease, to the history of the origins of the organism and to the relationship between it and its various animal hosts.

Despite relatively little genetic variation on the part of *Brucella*, and ability of the members of the genus to cross between hosts, specific hosts do none-the-less seem to be preferred by each strain. The hosts themselves can be very varied and include, in the case of *B. melitensis*, not just goats, but also stable fly. Sheep (also subject to *B. melitensis*) and stable fly can also host *B. ovis*. *B. ovis* (unusually) does not appear to affect humans, unlike most other strains, and itself seems to be the closest match to the common ancestor of the modern *Brucella* strains, dated by researchers in 2009 to 86,000-296,000 years. This is long before the known domestication of farm animals such as sheep and goats,

which is estimated to have been around 12,000-10,000 years ago, at the end of the last Ice Age, when the human exposure to the pathogens and other organisms carried by livestock originated.³ The most frequent examples of anthroponotic transfer are seen in the case of *B. melitensis*, *B. suis*, and *B. abortus*. As Ariza et al have observed 'Brucella melitensis remains the major cause of human disease worldwide, followed by *B. abortus* and *B. suis*,' however, they continue, 'rare but persisting cases of *B. canis* human infection and disease by novel Brucella pathogens of marine mammals have also emerged.'⁴ Looking at some of the other strains, we can see that cattle, bison, buffalo, deer, moose and elk are hosts to *B. abortus*; feral swine, pigs, hares, rodents, wild boar, reindeer, caribou and foxes host *B. suis*; dogs and their cousins host *B. canis*; dolphins, whales, polar bears, and (fresh-water and sea) otters host *B. ceti*; seals, sea lions and walruses host *B. pinnipedialis*; and the soil, as well as voles and foxes, seems to host *B. microti*. This list alone gives us an idea of its wide-ranging incidence; it can be detected across species (mammals and insects; on land and at sea; in all climes), and persists not only in animal or insect bodies, but also (depending on local conditions) for between two to three months in soil.⁵ Looking for evidence of the effects of Brucellosis and its incidence in the human population through time, genetic markers for *Brucella* bacteria have been found in archaeologically-recovered human spinal remains showing the effects of disease that date to the 10th-13th century in Albania. This suggests, Todd W. Fenton et al argue, that brucellosis was endemic to the region at least from the medieval period, and probably even earlier.⁶

Today, Brucellosis has a worldwide incidence. The World Health Organization records Brucellosis as one of the most commonly occurring zoonoses, and one that has a current pattern of re-emergence. *B. melitensis* in particular can be found worldwide and new cases among human subjects (infected by the ingestion of contaminated milk and dairy products) number c. 500,000 annually, though it still frequently goes unreported. Despite examples of successful eradication among livestock in the mid to late twentieth century (e.g. from cattle herds in Great Britain 1979), official monitoring has been needed to address its reintroduction (e.g. via cattle imports). Meanwhile, despite systematic official surveillance and professional guidance, those working with livestock and carcasses (including vets, stockmen and labourers, farmers, and abattoir workers) remain at particularly high risk of infection from *Brucella*.⁷ Brucellosis is still very difficult both to identify and to treat⁸ not only because of its characteristically variable presentation and the material difficulties of detection, (for example, *Brucella abortus* will often be undetectable in blood samples until the cow aborts her calf), but also because of unsystematic use of terminology such as 'acute', 'chronic' and 'relapse', and variable duration of intervention

used by those seeking to treat the disease in human subjects. It has been demonstrated that the reporting of clinical symptoms, regarding intensity, persistence and so on, and also therapeutic trials are frequently hampered by these difficulties.⁹ Meanwhile, government-funded studies of the incidence of brucellosis in non-human animals that have not been domesticated can become highly politicized, as can be observed with reference to the contamination of buffalo, and other large animal species designated as ‘wild’ in North America.¹⁰

It is not my intention here to run through a linear narrative of the discovery and study of brucellosis by, for example, describing the work of Burnett, Bang, Hughes, Zammit, Bruce, Mary Elizabeth Steele (Bruce’s wife) and Dr Joseph Caruna Sciciuna, and the Mediterranean Fever Commission. This history has in fact been contested, as Vassalo and Wyatt have both argued, with reference to the credit for discovering the link between *Brucella melitensis* and goats’ milk.¹¹ Rather, because Brucellosis may still be described as ‘an enigma in the 21st century,’¹² I intend instead to explore the ways in which those narratives about, and names for, Brucellosis circulated in Britain from the nineteenth to the mid twentieth century. In so doing, I will argue, we find that the history of research into and interest in Brucellosis maps perfectly onto the wider socio-political issues and the ideological eddies and currents attaching to animal, and human, disease and health more generally in each period. The very many names for Brucellosis reflect not only its empirical, biological characteristics, but also the very compartmentalized ways in which the research was undertaken. This in turn explains the various piecemeal and partial interventions we see in its history. The health of veterinarians, farmers and labourers who worked with livestock went unconsidered, because despite the high level of co-operation and collaboration in researching contagious abortion from the 1880s to the 1920s, it was the cow that was the focus of research, not her human handlers.¹³ Wages and living conditions being the primary foci of study with reference to the farm labourer; they were only enumerated at the broadest level, without reference to the actual work that they did with animals and therefore exposure to disease in the nineteenth century. Finally, as the focus of study for ‘Malta Fever’ was the military population in the Mediterranean, and the disease itself was perceived to be a tropical disorder that was really only prevalent overseas, the civilian population in the UK (including farm servants, and farmers and their families) who might have contracted it through the consumption of unpasteurized milk, not just the civilian population on Malta itself went unconsidered.¹⁴ Brucellosis therefore provides us with a particularly interesting opportunity in the study of the ways in which different groups were perceived and classified historically in debates about the relationship between animal and human health and the actual effects of this. The invisibility of Zammit’s work in the taxonomic record (the full credit being given to Bruce in the name ‘Brucellosis’) is itself emblematic

of the dominant ideas of the period at which the Mediterranean Fever Commission was operating. This demonstrates not only the importance of thinking exhaustively and comprehensively about health, but also that we must at all times keep our eyes on the geographical horizon; as human and non-human animals circumnavigated the globe, so too did infections (not always spotted or policed), and so too ideas about disease.

NARRATIVES

As ‘Crimean fever’ the disease came to the attention of British researchers in the context of the 1854-1856 Crimean War and the lasting damage it inflicted on military personnel. As H. Vivian Wyatt has argued, there was little medical interest in the disease in Malta until, as a ‘Tropical’ disease, it came to the attention of medical practitioners operating under the Island’s British military presence. Malta fever, Wyatt rightly observes, ‘was endemic throughout the Mediterranean, but [its] etiology was recognized and investigated because it affected soldiers and sailors on the island of Malta’.¹⁵ Prevention of its spread continued to be a problem among the civilian population despite its subsequently successful management among military and naval forces. As we can therefore see from the publications connected to the process of research, and the fiction connected with that process, Malta fever was a disease framed in the UK during the late nineteenth and early twentieth century almost entirely by the great distances of the British Empire and British military expeditions. As by J. W.H. Eyre, M.D., M.S. URH., D.P.H. Cantab., bacteriologist to Guy’s Hospital, lecturer on bacteriology at Guy’s Hospital Medical School, and Member of the Advisory Board of the Mediterranean Fever Commission said of it in 1908: ‘The careful study of this disease appeals to us not only as medical men but as members of a great empire’.¹⁶ As such, the Mediterranean Fever Commission’s work on brucellosis was therefore widely disseminated and of apparently considerable interest to the educated public, such as readers of the *Athenaeum*, who read about it too in the context of patient and heroic tales of the battle against all tropical diseases.¹⁷ Criticism of the research, when it did occur, came from anti-vivisectionists, (who belonged to a similar social strata to those showing a general interest in the subject), who objected to Bruce’s research methods with goats (which Bruce defended).¹⁸ Known simply as ‘Malta fever,’ in this way Brucellosis became part of the intellectual stock in trade of the Victorian metropole – and led to representations from the Mediterranean objecting to its common name.

It was already known when J.W.H. Eyre, M.D., M.S. Durh., D.P.H. Cantab., Bacteriologist to Guy’s Hospital, Lecturer on Bacteriology At Guy’s Hospital Medical School, and Member of The Advisory Board of The Mediterranean

Fever Commission, spoke before the Royal College of Physicians in 1908, that the disease had a widespread incidence. And, in support of the world-wide significance of his and the Commission's work, he detailed the locations at which it had been found to exist, which leaves us with a trace of the geography of its investigation. The various localities in which Melitensis septicemia has been conclusively proved to exist as an endemic disease may then be tabulated as follows:

Europe

- Austria (Trieste)
- Grecian Archipelago.-Athens, Nauplia, Platsea, Cephalonia (Argostolia)
- Corfu, Crete
- Italy.-Ancona, Benevento, Campobasso, Casserta, Cittanova, Fermo, Leghorn, Naples, Padua, Pisa, Rome, Terano.
- Mediterranean Sea.-Balearic Isles (Mahon), Candia, Corsica (Ajaccio), Cyprns, Gozo, Malta, Sardinia, Sicily (Catania, Messina, Palermo, Syracuse).
- Spain.-Gibraltar.
- Turkey.-Constantinople, Salonika.

Asia

- Arabia.-Aden.
- Asia Minor.-Beyrout, Jerusalem, Smyrna.
- Assam.-Tezpur.
- China.-Hong-Kong. Shanghai.
- India.-Agra, Allahabad. Bombay, Calcutta, Delhi, Ferozepore, Jalandhar, Jhelum. Lucknow, Meenmer, Multan, Nowshera, Rawalpindi, Secunderabad, Simla, Subathu, Swat Valley.

Africa

- Algeria.-Algiers.
- Tunis.-Cape Bon, Goulletta, Tunis.
- Egypt.-Alexandria, Cairo, Massowah, Port Said, Suakin.

South Africa

- Basutoland-Leribe, Maseru, Mohalieshoek.
- Cape Colony.-Barkly West, Beaufort West, Clanwilliam, Griquatown, Hanover, Hopetown, Kenhardt, Kimberley, Murraysburg, Pearston, Petrusville, Prieska, Richmond, Somerset East, Upington.
- Native Provinces.-Hay. Maclear, Mount Fletcher, Ugie.
- Orange River Colony.-Bethulie, Boshof, Fauresmith, Ficksburg,
- Koffyfontein, Luckhoff, Philipolis, Reddersburg, Senekal

Springfontein, Vrede, Wepener.

- Transvaal.-Barberton, Boksburg, Dordrecht, Johannesburg.

America

- North America-Mississippi Valley.
- South America-Brazil, Venezuela, Montevideo.
- West Indies-Cuba, Porto Rico.
- Pacific Ocean-Fiji Islands, Philippine Islands (Manila).
- Atlantic Ocean-Canary Islands.¹⁹

Its spread, and its variable presentation led to a complex history of naming, as investigators failed to realize that they were looking at the effects of the same organism. When we attempt to engage with the history of Brucellosis, much therefore depends on what we ask the material; a search in the literature for ‘Malta fever’ will yield different results to a search for ‘remittent fever’ – the latter incidentally record children’s deaths, many of which may have been from ‘undulant fever’, whereas the former does not. Ten years before, Surgeon-Captain M. Louis Hughes, Army Medical Staff, Malta, expressed a very real sense of frustration arising from the disease’s history when he stated of the nomenclature then at hand: ‘Enough has been written and published about this fever to prove its specific and separate nature, but, unfortunately, no suitable name has been suggested by which it may be returned., ...’The following synonyms have been used:-

Mediterranean gastric remittent fever (Marston, 1861; Boileau, 1865; Chartres, 1866); remittent fever (Official Returns of the Royal Navy and Civil Government of Malta); la febbre gastro-biliosa (Guilia, 1871); febris sudoralis (Tomasselli, 1880) ; febbre miliare (Frederici, 1885, &c.); febris complicata (Veale, 1879); intermittent typhoid fever (Eorrelli, 1887); adeno-tifo (Cantani, 1878); febricola typhosa (De Renzi, 1884); febbre typhoidea atipica (Capozzi, 1885); ileo-tifo a forma sudcrale (Jaccoud, 1885-6); pseudo-tifo (Guiffre, 1893); typho-malania fever (Maclean, 1875-85, &c.); faeco-malarial fever (Donaldson, 1876); febbre continual epidemica (Tomaselli, 1886); simple continued fever (Military returns); Mediterranean fever (Burnett, 1810 ; Guiffre, (1893, &c.); rock or Gibraltar fever (Turner, 1884; Moffett, 1889, &c); Malta fever (Oswald, Wood, and Notter, 1876; Bruce, 1887, &o.); Neapolitan fever (Borrelli, 1887; Galassi, 1883); febbre infettiva atipica (Rummo, 1881); pythogenic septicmmia (Moffett, 1889); febbre climatica (Pasquale, de (Conciliis, 1889, &c.); recurrent, country, sewage, mephitic, cesspool, town, Cretan, Cyprus, Levant, &c., fever.’²⁰

A list such as this writes up the history of investigation as well as incidence for us. The naming becomes part of the evidence, and the substance of our investigation. But, the observation Hughes made at the time was that this difficulty in naming, even when researchers were working at the same period, was leading in his day to a very real difficulty in actually tackling the disease. 'Until such a [standardised] name is inserted in the official nomenclature of diseases' he maintained, 'our accurate knowledge of its causation and prevention will fail to be advanced to any great or general extent'. On that basis he argued a case for it to be called 'Undulant Fever',²¹ which was given considerable credence and widely adopted until the findings of the Malta Fever Commission. At that point, defenders of the Maltese quickly leapt in with delicately, yet firmly, worded letter aimed at disassociating the island in particular from the taint of all names linking Brucella to the Mediterranean basin. Hence a letter to Eyre, published in *The Lancet* in 1907, before his lecture tour:

Oct. 24th, 1907

HONOURED COLLEAGUE, – At the Medical Academy of Palermo, and afterwards at Milan, in a lecture I delivered in May on Malta fever, I proposed that henceforward, in order to do away with an inappropriate denomination, this infection should be called septicaemia of Bruce (setticemia del Briiee).

I hope that this nomenclature, which I proposed and have used throughout a publication to be issued shortly, will meet with your approval and that of the medical profession in England and that you will discard with pleasure a name which is an unjust slight on the Island of Malta and the Mediterranean coast, and gladly see on record the name of an illustrious colleague to whom we are indebted for the discovery of the specific agent of the said infection.

I authorise you to make public this request of mine in such English journals as you may think advisable.

Yours faithfully,

ARNALDO TRAMBUSTI,

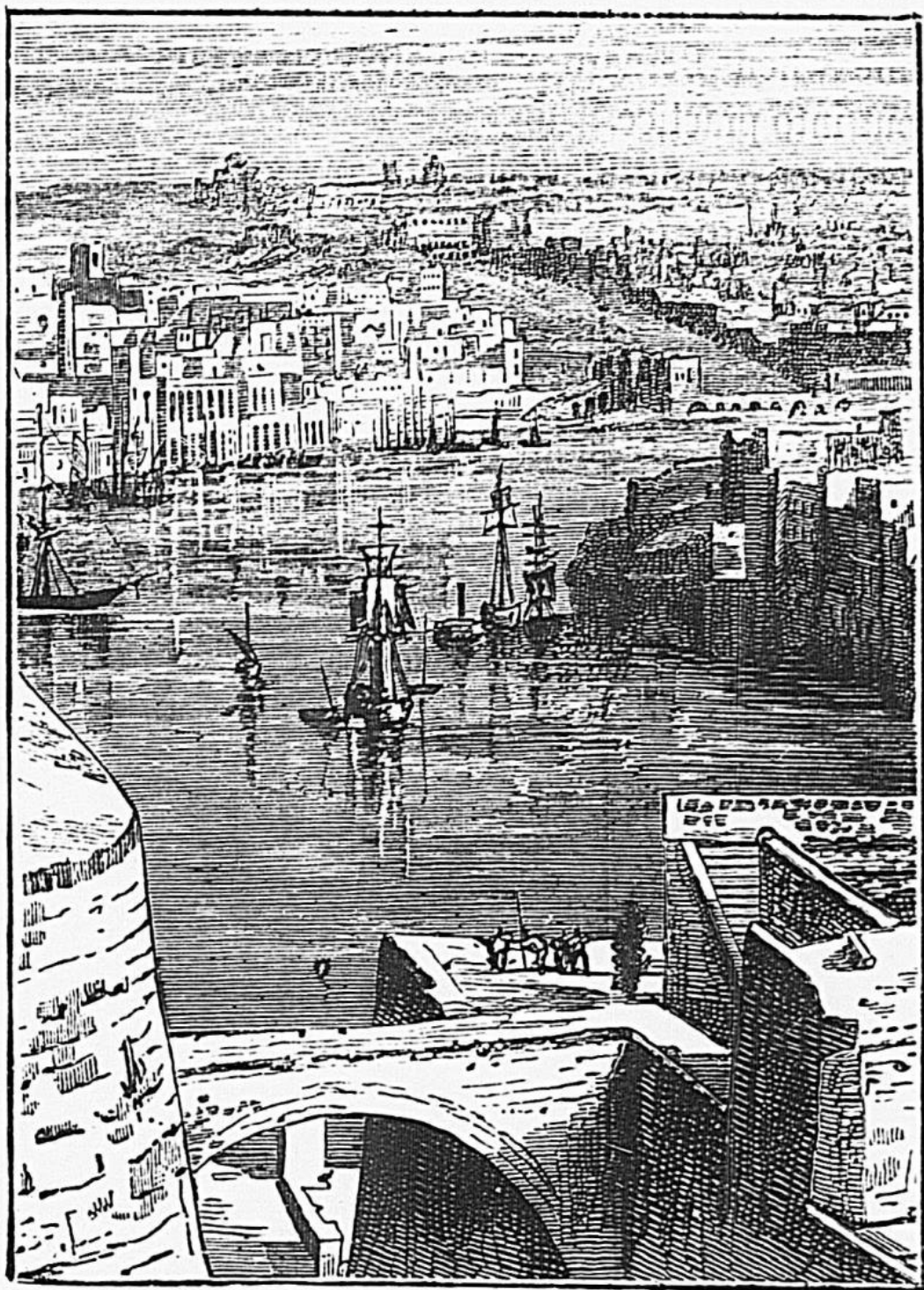
Professor of General Pathology at the University of Palermo.
To J.W.H. Eyre, M.D., Bacteriological Laboratories,
Guy's Hospital, London.²²

Such a letter as this, submitted to *The Lancet* via Eyre, was part and parcel of the authority that had to be built up before the final naming of Brucella as Brucella. But, it also reveals the keen interest taken at the time by (human) medical professionals in the Mediterranean in the disease as well as in the significance of naming.²³

The disease itself reputedly laid claim to some very prominent victims in the nineteenth century – as ‘Crimean Fever’ or ‘Mediterranean Fever’ it was incorporated most notably into commonplace narratives of Florence Nightingale’s life²⁴ – and it became a trope of incidental and enervating discomfort that offered useful moments of grounding verisimilitude or sympathetic peril in the short fiction of the period. Bernard Pleydell, ‘the senior subaltern of one of the Garrison Artillery Batteries in Malta,’ for instance, cast as perfectly unromantic and unremarkable at the outset of *Pleydell’s Predicament* (Fig. 1), a short story by C.E.C. Weigall in *The Argosy* (1896), succumbs to Malta fever in order to be nursed back to health by ‘Molly’, whom he marries on his sickbed (and through whom he gains access to £3,000 a year). Debilitated and emasculated by Brucellosis, the central male character temporarily slipped into a rags-to-riches Cinderella narrative, during which through marriage he moved up the social scale. In a rather more gothic tale attributed to White Thomas Pilkington, ‘The Shrouded Figure’ *Blackwood’s Edinburgh Magazine*, (1891) a man enervated and ‘ailing for some time back of Malta fever,’ with the protagonist, see a cloaked figure/harbinger of death.²⁵

WORKING WITH ANIMALS

As an object of investigation, this was not a disease that fascinated for its occupational health impact, however, even when of interest to agriculturalists and agricultural policy-makers. As charted by Corley & Godley, from 1908, along with other diseases under similar investigation at the time, Board of Agriculture Veterinary Department officials looked into the diagnosis of Brucellosis within a wider policy framework of disease control (as managed by limits being placed on livestock movement coupled with slaughter). From 1912, the newly-established veterinary section of the Wellcome Physiological Research Laboratory then began to look into its pharmaceutical treatment. By the interwar period, vaccination (discussed widely in Canada) had become the focus of the new Disease of Animals Branch of the Board of Agriculture and Fisheries in 1930, which was later pursued by commercial enterprises like Glaxo post-war.²⁶ But, rather than this forming a focus for the investigation of occupational health, other than in medical personnel employed by the forces, this was framed by the impact on farms as businesses.



MALTA.

Fig. 1. Illustration of Malta (from *Plyedell's Predicament* a short story by C.E.C. Weigall in *The Argosy* (March 1896) Vol. 61, pp. 287-304)



Fig. 2. Maltese Man Milking a Long-haired Goat (Possibly a Messinese), c. 1920s. Until the 1940s, Maltese Consumers Preferred to have their Milk Direct from the Goat, so the Goats were taken to the Villages and Milked on Demand on the Doorstep.

(Image from <http://vassallohistory.files.wordpress.com/2013/01/goatmilk.jpg> Accessed 8 December 2014)

As noted, the main focus for those studies interested in its impact on human health was the impact on military personnel, especially those stationed in the Mediterranean, hence the Maltese-based Commission. Parliamentary reports designed to address diseases such as Cattle Plague or Swine Fever, in the latter part of the nineteenth century, as Hughes coined the term ‘Undulant Fever’, though very detailed, did not seek out information by way of the incidence of other diseases, and focused on the impact on the farmer or stockman as a businessman and the financial losses incurred through the loss of stock, not on their health. The thinking with reference to the possible dangers of the transmission of disease to humans from other animals was focused almost entirely on issues of the consumption (ingestion or other use of animal products, especially milk), not the potential dangers to human handlers that might be inherent to the processes of production or management of animal disease. Occasionally, with reference to *B. melitensis*, the potential problem of farmers, labourers and their families drinking unpasteurized milk at home came up, but the specific risk posed by Brucellosis in the form of *B. abortus* to labourers and farmers, let alone vets, does not seem to have been addressed formally at the level of policy making in Britain until the 1960-70s. In a Report published in 1972, for example, on the possibility that Brucellosis might be covered by the Industrial Injuries Act (1965), it was found that 33 people, employed ‘in slaughterhouses, as veterinary workers or inseminators, or in various occupations on farms which could involve work with animals’, had sought compensation for injury due to Brucellosis.²⁷ Most of these had their claims upheld, i.e. were deemed to have become ill because of their employment, though only 17 initially were aware that they could claim for industrial injury – possibly because of the presentation of the disease itself, which may have led the others simply to take sick leave due to incapacity, until additional investigation suggested that the cause was Brucellosis, and then the individuals in question needed to be aware that they could claim for this as an industrial injury, i.e. sickness due to their work. The focus in the report was *B. abortus*, and in the end the recommendation was to protect those in occupations ‘involved, to a greater or lesser extent, work with cattle or with the products of cattle.’ i.e. farm workers, veterinary workers, slaughterhouse workers, laboratory workers or other employment involved in handling, caring for, treating, examining cattle, their carcasses, parts of carcasses or products.²⁸

This might well have been because of the established human medical research focus in Britain on the military, given that bacteriologist Dr Alice C. Evans (employed in the US Department of Agriculture from 1929) certainly made the link between 1918 and 1924 between *bacillus abortus bovinus* (known from Bangs’ research to be a cause of abortion in cattle) and *micrococcus melitensis* which she argued had a very similar presentation as a pathogen that she termed

‘brucellosis’ in human subjects. Moreover, there was an emerging concern about the infection of laboratory workers from the 1920s (Evans herself contracted the disease through her laboratory research), and Dr. Karl Friederich Meyer (who had confirmed the *abortus* and *melitensis* link and established the genus *Brucella* from his own research in 1920) published a paper in 1935 with J. Geiger on ‘The Increasing Importance of brucellosis as an occupational hazard’ in the *Journal of the American Veterinary Association*. This was grounded in his experience of ensuring that agricultural education should include an education in bacteriology. However, in large part due to the shifting sands of diagnosis and the complex and ‘remittent’ nature of the disease in presentation, even in America there was widespread scepticism about the spread and impact of brucellosis within the human population at the level of public health, as well as an occupational hazard among the farming population and vets, at least until the 1950s.²⁹

In the UK, until work-study methodologies began to be adopted by the British industry in the 1950s-1960s (and setting aside social commentaries aimed at improving the labourer’s economic or political condition, or nostalgic accounts of golden age practices), agricultural labour was also addressed more often in terms of the broad questions of working hours, housing and wages, rather than the details of the actual work at hand. This historic weakness obscured question of labourer’s or farmer’s connection with the spread or experience of disease and the development of what *Fream’s Elements of Agriculture* called ‘Animal Hygiene’.³⁰ This, Fream stressed, if not managed, led to lost production as well as the death of an animal or animals through illness. Farmers, it stated, ‘can do much good to assist in reducing the incidence of ill health by good management and good feeding of livestock with attention to hygienic measures’. Moreover, they ought also to be knowledgeable about the symptoms of ill health in order to assist the ‘veterinarian in making a rapid and accurate diagnosis.’³¹ The text admonished farmers who ‘tend to accept ill health in stock as a normal hazard of farming’, when in fact ‘much of the loss of production caused by diseases could be prevented by paying greater attention to their prevention ... and ... to the control of certain disease conditions.’³² In order to address this, farmers were instructed to pay close attention to their stock and the behavior of individual animals, ‘any departure from the normal should act as a warning to the stockman.’ Stockmen post-War had become crucial players in watching for and understanding ‘changes in appearance, posture or movement, or abnormalities of respiration, pulse rate, temperature, appetite, rumination in cattle and sheep, defecation, urination, the oestrus cycle or productivity.’³³ Fream therefore gave clear guidance on the ‘hygienic measures in livestock management’ that focused on animal housing, equipment, feeds, cleaning and finishing on ‘Stockmen’.³⁴

‘Stockmen. There is little point in employing hygienic measures on the farm if stockmen move at random between infected and healthy stock; disease organisms can be carried on the person and clothing of stockmen. This method of spreading diseases should not be difficult to overcome. The only general recommendation which can be given is that animals sick with infectious diseases should not be attended until work on healthy stock is completed. After attending to sick animals the operator should wash his hands and boots.’³⁵

Though the risks to the stockmen are not described, in all, the stockman, it becomes clear, did therefore come to be seen as an important element within the practice of ‘animal hygiene,’ not only as an educated, skilled labourer who worked with other professionals, but also as a potential vector of disease in the standard agricultural text by the post-war period. Fream himself had originally written on the emerging field of pathology, the evidence for microspordia causing disease, and the emerging understanding of bacteriology and the relationship of bacteria to disease, in assessing the potential value of the biological sciences for agriculture, in an article for the *Journal of the Royal Agricultural Society of England* in 1891.³⁶ But, in 1962, the text was responding to the context and consequences for animal health of the adoption of new technologies within animal husbandry and the move by some to intensive systems.

In contrast to the twentieth century, however, it is surprisingly difficult to determine how many labourers were handling livestock in the last quarter of nineteenth century, when Brucellosis in the form of Malta fever and Bang’s disease were under initial investigation. Though there were those who had more responsibility than others, in the Victorian period anyone within the agricultural class might potentially work with animals. The difficulties of interpreting the information collected in the decennial censuses were discussed in a paper presented to Parliament in 1895, and have been discussed widely by historians, however few have considered this with reference to livestock production.³⁷ The occupational category ‘farm labourer’ could be very elastic – and for historians who have sought to understand wages and working conditions, which varied not only by occupation, but also by region at the time, this is an ongoing difficulty. Though the census for England and Wales in 1891, for example, added some detail to the category of ‘farm labourer,’ it really did very little to break this down in such a way as to provide us with very much information about the number of men and women working with any of the animals from whom they may have contracted any form of Brucellosis on farms. Though it might be supposed that those classified as graziers specialized in some form of livestock production, the same difficulty of getting to the detail occurs with them, as they

were returned alongside farmers in 'Farmer, Grazier'. Shepherds³⁸ were enumerated specifically, as were those returned under the classification 'About Animals' as employers, employees and self-employed under the headings 'Cattle, Sheep, Pig-Dealer and Salesman' and 'Drover' (also 'Gamekeeper', 'Dog, Bird, animal-keeper, Dealer', 'Knacker, Catmeat-dealer, Vermin Destroyer'). Under the classification 'Food' we find 'Milk seller, Dairyman', but the agricultural labourers and farm servants who handled livestock on a daily basis were ultimately returned together with all farm workers.³⁹

The difficulty with the census reflects the structure of agricultural production at the time, as well as the focus of investigation from the period. During the nineteenth-century, despite some regional specialization (e.g. in cattle in the South West, arable in East Anglia, pigs from Suffolk to Surrey) and a move towards a larger amount of land being put down to grass in the last quarter of the century, British farms remained predominantly mixed to some degree. Having a mixed farm allowed producers to use animal manure as well as artificials on the farm, and many still provided a lot of animal feed from their own produce as well as buying in oil cake and other supplements. Though agricultural labourers might have spent time working with stock, and tended to be paid more if they did because of their longer working hours, they were therefore also expected to undertake other tasks on the farm and were not necessarily specialists as such, unless they were Shepherds or worked with horses. There were farms that specialized increasingly in dairy production, (according to reports in the 1880s this was in response to the Agricultural Depression, during which dairy farmers supposedly fared better than corn producers),⁴⁰ and by 1921 after considerable revision of the classification of occupations and industries a total of 57,258 males and 10,328 females over the age of 12 were returned as 'Agricultural labourers working with cattle' in England and Wales (dairy or beef unspecified).⁴¹ However, even by the interwar period, when the number of cows in milk were returned as rising from 1,943,666 in 1919 to 2,236,829 in 1938, those interested solely in the progress of the dairy industry, such as Arthur Guy Enock (1870-1956), author of the very detailed *This Milk Business a study from 1895 to 1943* (1943), still found it hard to assess exactly how many labourers worked regularly or casually within the bounds of dairy farming.⁴²

Though the head of cattle increased nationally between the wars, the size of herds before the Second World War was still reported to be relatively small: according to Enock's analysis of the situation, 60% of farmers owned fewer than 14 cows. As an engineer who specialized in refrigeration and dairy technology and research, who had lived and worked in South Africa, Italy and Australia, one might have expected Enock to discuss Bruce's research in detail.

Enock certainly cited American reports of ‘milk borne disease outbreaks’ in his book, as well as Canadian research into related topics (such as the transmission of pathogens by flies) from the period of the Mediterranean Fever Commission. It is evident, however, that, based on the widespread medical understanding that *B. melitensis* was not endemic to the UK, Enock, who was well-connected with the Ministry of Health, believed that little needed to be said.⁴³ So, though hygiene, the transmission of disease by human carriers, tabulated epidemics caused by milk in Britain, and the history of ‘dairy bacteriology’ were all presented for discussion by Enock, there was little mention of any *Brucella* strain, other than passing reference to the ‘germ’ or ‘bacteria of undulant fever’, which he said based on a finding by Dr Bigger of Dublin ‘survives in dry dust for many months’.⁴⁴ It is perhaps more surprising that the labourer was not discussed as a vector for the transmission of *B. abortus*, given the focus in his text on the need for increased production and the danger that ‘abortion storms’ presented to the success of the dairy farmer, however, because the labourers working with cattle were not quantified, this issue could not be explored. The issue of ill health arising from the drinking of milk (either raw or contaminated after pasteurization) was therefore framed in the UK in the 1940s as a matter purely of public health and not an issue on the farm or for vets.

CONCLUSIONS

To get to the heart of the issue with reference to the agricultural labourer, stockmen and vets on farms in Britain, it would be necessary to look at the specialist periodical press, such as the *Farmers Weekly* or the *Farmer & Stockbreeder* in order to look at the development of the advice on health provided to stockmen and thereby get a sense of the emergence of brucellosis as a conscious hazard to health due to employment on a farm or with farm animals. However, as noted towards the beginning of this article, the sources only yield evidence based on the terms searched for and the terms to search for in relation to brucellosis are many. The focus in Britain at the time at which safety advice around health focused, as the 1972 Report did, largely on *B. abortus* and though there is sometimes passing mention of contamination through drinking unpasteurized milk, there is little interest in other strains of brucellosis or even a very real interest in the effects of drinking raw milk. It is only when other search terms are used that we begin to see that perhaps consumers were also exposed to brucellosis through ingestion, particularly before pasteurization became commonplace, so that this may have impacted in Britain as well as the Mediterranean. It would take further work to begin to disentangle that material, especially because at the time, in the Britain, even when it came to the potential dangers of what were seen as tropical diseases, other problems loomed much larger even when we know there was widespread debate and interest within

Britain about the impact of (what would come to be called) brucellosis overseas. The *Journal of the Royal Agricultural Society of England (JRASE)* does not mention the Crimea/Crimean/fever/remittent in 1857, for example, being more concerned with Rinderpest.⁴⁵ But, interests also shifted, led by the research of the period that highlighted the case to be made on the farmer's business: contagious abortion was reported on in *JRASE* in 1914.⁴⁶ Still, at the time that Bruce and the Commission of Enquiry were working in Malta, others were working on Contagious Abortion in the UK, and the two were perfectly distinct investigations. To fully grasp the potential impact of the circulation of an organism like brucellosis between animals, humans, (even across soil and insects), the architects of enquiry must be able to observe it (at the technical level), and then recognize it and its effects in human and animal (insect) hosts. To do that, they need not only to observe the link empirically, but also a common language of enquiry, including terminology for the disease/organism and its presentation. Though there was interest in Crimean/Malta Fever as the public level and the level of policy makers, who drove scientific enquiry forward, and they had the equipment, that interest was so bounded by the framework and attitudes of empire and the impact of disease on the army and navy, that there was little or no reason for that body of experts to look at 'remittent fever' in children, or 'abortion storms' in British cattle.

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